

WHAT IS CLAIMED IS:

1. A method for manufacturing a silicon carbide single crystal, the method comprising the steps of:

setting a silicon carbide single crystal substrate as a seed crystal in a reactive chamber;

introducing a raw material gas including a silicon containing gas and a carbon containing gas into the reactive chamber;

growing a silicon carbide single crystal from the silicon carbide single crystal substrate;

heating the raw material gas at an upstream side from the silicon carbide single crystal substrate in a gas flow path;

keeping a temperature of the silicon carbide single crystal substrate at a predetermined temperature lower than the raw material gas so that the silicon carbide single crystal is grown from the silicon carbide single crystal substrate;

heating a part of the raw material gas, which is a non-reacted raw material gas and does not contribute to crystal growth, after passing through the silicon carbide single crystal substrate; and

absorbing a non-reacted raw material gas component in the non-reacted raw material gas with an absorber.

2. The method according to claim 1,

wherein the raw material gas is heated at a temperature in a range between 2300°C and 2700°C in the step of heating the raw material gas at the upstream side, and

wherein the silicon carbide single crystal has a temperature of a growth surface in a range between 2100°C and 2600°C.

3. The method according to claim 1,
wherein the part of the raw material gas has a second gas flow opposite to a first gas flow of the raw material gas flowing toward the silicon carbide single crystal substrate.

4. The method according to claim 1,
wherein the temperature of the silicon carbide single crystal substrate is lowered to be lower than temperature around the silicon carbide single crystal substrate.

5. The method according to claim 1, further comprising the step of:

stirring the raw material gas in the step of heating the raw material gas at the upstream side before the raw material gas is introduced to the silicon carbide single crystal substrate.

6. The method according to claim 1, further comprising the step of:

discharging the part of the raw material gas without including silicon and carbon.

7. A method for manufacturing a silicon carbide single crystal, the method comprising the steps of:

mounting a reactive chamber in a vacuum chamber in such a manner that the reactive chamber is surrounded by a heat insulation of the vacuum chamber;

setting a silicon carbide single crystal substrate as a seed

crystal in the reactive chamber;

introducing a raw material gas including a silicon containing gas and a carbon containing gas into the reactive chamber;

growing a silicon carbide single crystal from the silicon carbide single crystal substrate;

discharging a part of the raw material gas, which is a non-reacted raw material gas and does not contribute to crystal growth, after passing through the silicon carbide single crystal substrate; and

removing a non-reacted raw material gas component in the non-reacted raw material gas in such a manner that the non-reacted raw material gas component is converted from a gas state to a solid state in the vacuum chamber before the non-reacted raw material gas component is absorbed in the heat insulation.

8. Equipment for manufacturing a silicon carbide single crystal, the equipment comprising:

a reactive chamber for accommodating a silicon carbide single crystal substrate as a seed crystal, wherein a raw material gas including a silicon containing gas and a carbon containing gas is introduced into the reactive chamber so that a silicon carbide single crystal is grown from the silicon carbide single crystal substrate;

a heater for heating the raw material gas to be introduced to the silicon carbide single crystal substrate up to a temperature higher than a temperature of the silicon carbide single crystal substrate; and

an absorber,

wherein the reactive chamber has a construction in such a manner that a part of the raw material gas, which is a non-reacted raw material gas and does not contribute to crystal growth, flows toward a downstream side from the silicon carbide single crystal substrate after passing through the silicon carbide single crystal substrate,

wherein the heater heats the part of the raw material gas after passing through the silicon carbide single crystal substrate, and

wherein the absorber absorbs a non-reacted raw material gas component in the non-reacted raw material gas after heating the part of the raw material gas.

9. The equipment according to claim 8,

wherein the reactive chamber has a predetermined temperature gradient in such a manner that a temperature in the reactive chamber is reduced as it goes toward the silicon carbide single crystal substrate.

10. The equipment according to claim 8,

wherein the non-reacted raw material gas is discharged along with an inner wall of the reactive chamber after passing through the silicon carbide single crystal substrate.

11. The equipment according to claim 8,

wherein the reactive chamber is a cylinder having a cover,
wherein the raw material gas is introduced from an opening of the reactive chamber into a middle portion of the reactive chamber

so that the raw material gas is led to the silicon carbide single crystal substrate,

wherein the raw material gas changes its flowing direction reversely after the raw material gas reaches the silicon carbide single crystal substrate, and

wherein the non-reacted raw material gas flows from the opening of the reactive chamber to the downstream side along with the inner wall of the reactive chamber.

12. The equipment according to claim 8, further comprising:
a tube for introducing the raw material gas toward the reactive chamber,

wherein the reactive chamber is separated from the tube.

13. The equipment according to claim 12,
wherein the tube has an upper opening, which is disposed in a middle portion of the reactive chamber.

14. The equipment according to claim 13,
wherein the silicon carbide single crystal substrate is movably supported in the reactive chamber, and
wherein the silicon carbide single crystal substrate is movable toward and against the tube.

15. The equipment according to claim 14,
wherein the tube has an outer circumference, which is separated from an inner wall of the reactive chamber.

16. The equipment according to claim 15,
wherein the upper opening of the tube is apart from a growth surface of the silicon carbide single crystal by a predetermined distance, and

wherein the distance is equal to or smaller than 20mm.

17. The equipment according to claim 16,
wherein the distance between the growth surface of the silicon carbide single crystal and the upper opening of the tube is equal to or smaller than 5mm.

18. The equipment according to claim 8, further comprising:
a heat insulation disposed around the silicon carbide single crystal substrate.

19. The equipment according to claim 8, further comprising:
a coolant gas pipe for introducing a coolant gas in order to exchange heat between the coolant gas and the reactive chamber so that temperature of the silicon carbide single crystal substrate is lowered to be lower than temperature around the silicon carbide single crystal substrate.

20. The equipment according to claim 8,
wherein the heater includes a plate having a plurality of through holes,

wherein the plate is disposed in a gas flow path, and

wherein the raw material gas flows through the through holes

of the plate so that the raw material gas is stirred.

21. The equipment according to claim 8,
wherein the absorber is made of porous carbon, carbon felt
or carbon heat insulation.

22. The equipment according to claim 8, further comprising:
a hydrogen separation film disposed on an outlet of the
reactive chamber,
wherein the hydrogen separation film passes a hydrogen gas
only.

23. The equipment according to claim 8,
wherein the reactive chamber includes a cylinder and a base,
and
wherein the base supports the silicon carbide single crystal
substrate, and is movable in the cylinder.

24. Equipment for manufacturing a silicon carbide single
crystal, the equipment comprising:
a reactive chamber disposed in a vacuum chamber;
a heat insulation for surrounding the reactive chamber;
a silicon carbide single crystal substrate as a seed crystal
disposed in the reactive chamber;
a tube for introducing a raw material gas including a silicon
containing gas and a carbon containing gas into the reactive chamber
so that a silicon carbide single crystal is grown from the silicon

carbide single crystal substrate; and

an absorber disposed between an outlet of the reactive chamber and a heat insulation of the vacuum chamber,

wherein a non-reacted raw material gas component in a non-reacted raw material gas, which does not contribute to crystal growth, is converted from a gas state to a solid state so that the non-reacted raw material gas component is absorbed in the absorber.

25. The equipment according to claim 24,

wherein the absorber is displaced during crystal growth so that a portion of the absorber for absorbing the non-reacted raw material gas component is changed.

26. The equipment according to claim 25, further comprising:

a heater for heating the raw material gas to be introduced into the reactive chamber,

wherein the raw material gas is heated up to a maximum temperature before introducing into the reactive chamber,

wherein the silicon carbide single crystal substrate has a temperature lower than the maximum temperature so that the silicon carbide single crystal is grown from the silicon carbide single crystal substrate, and

wherein the absorber is displaced in a moving direction, to which a portion of the absorber absorbed the non-reacted raw material gas component leaves from a portion of the maximum temperature in the vacuum chamber so that a temperature of the portion of the absorber is lowered.

27. The equipment according to claim 26,
wherein the moving direction of the absorber is a direction,
to which the portion of the absorber absorbed the non-reacted raw
material gas component leaves from the silicon carbide single
crystal substrate through the portion of the maximum temperature
in the vacuum chamber.

28. The equipment according to claim 25,
wherein the absorber has a moving velocity in a range between
1mm/hr and 100mm/hr.

29. The equipment according to claim 24, further comprising:
another absorber disposed outside of the reactive chamber,
wherein the reactive chamber has an emission outlet for
discharging the non-reacted raw material gas,

wherein the other absorber is disposed around the emission
outlet,

wherein the raw material gas flows into the reactive chamber
in an axial direction of the vacuum chamber having a cylindrical
shape, and

wherein the non-reacted raw material gas component in the
non-reacted raw material gas discharged from the reactive chamber
is converted from a gas state to a solid state so that the non-reacted
raw material gas component is absorbed in the other absorber.

30. The equipment according to claim 24,
wherein the absorber is made of carbon heat insulation, porous

carbon, carbon plate, silicon carbide, tantalum plate, or tantalum carbide plate.

31. Equipment for manufacturing a silicon carbide single crystal, the equipment comprising:

a reactive chamber disposed in a vacuum chamber;

a heat insulation for surrounding the reactive chamber;

a silicon carbide single crystal substrate as a seed crystal disposed in the reactive chamber;

a tube for introducing a raw material gas including a silicon containing gas and a carbon containing gas into the reactive chamber so that a silicon carbide single crystal is grown from the silicon carbide single crystal substrate;

a space for separating out a non-reacted raw material gas component in a non-reacted raw material gas, which does not contribute crystal growth,

wherein the space is disposed in a place, temperature of which is gradually reduced, and

wherein the space is surrounded by the heat insulation disposed in a gas flow path in the vacuum chamber, the gas flow path being disposed from an outlet of the reactive chamber to an emission pipe in the vacuum chamber for discharging the non-reacted raw material gas.

32. The equipment according to claim 31,

wherein the outlet of the reactive chamber is disposed on a side of the emission pipe in the vacuum chamber from a portion of

a maximum temperature in the vacuum chamber.

33. The equipment according to claim 31,
wherein the gas flow path in the vacuum chamber from the outlet of the reactive chamber to the emission pipe in the vacuum chamber passes through the portion of the maximum temperature in the vacuum chamber, and

wherein the tube includes another heat insulation, which is exposed in the gas flow path from the outlet of the reactive chamber to the space.

34. The equipment according to claim 31, further comprising:
an inert gas pipe for introducing an inert gas toward the emission pipe in the vacuum chamber.

35. The equipment according to claim 34,
wherein the inert gas including a crystal core is spread in the space.

36. The equipment according to claim 35,
wherein the crystal core is a fine powder made of material having a high melting point.

37. The equipment according to claim 36,
wherein the material having the high melting point is silicon carbide, tantalum, tantalum carbide or carbon.

38. The equipment according to claim 31,
wherein the heat insulation for surrounding the space includes
an air-tight sheet disposed on a surface of the heat insulation.

39. The equipment according to claim 38,
wherein the air-tight sheet is made of graphite, tantalum or
tantalum carbide.

40. Equipment for manufacturing a silicon carbide single
crystal, the equipment comprising:

- a reactive chamber disposed in a vacuum chamber;
- a heat insulation for surrounding the reactive chamber;
- a silicon carbide single crystal substrate as a seed crystal
disposed in the reactive chamber;

- a tube for introducing a raw material gas including a silicon
containing gas and a carbon containing gas into the reactive chamber
so that a silicon carbide single crystal is grown from the silicon
carbide single crystal substrate; and

- a separator for separating out a non-reacted raw material gas
component in a non-reacted raw material gas, which does not
contribute to crystal growth,

- wherein the separator is disposed in a part of a gas flow path
in the vacuum chamber, the part of the gas flow path being disposed
from an outlet of the reactive chamber to an emission pipe in the
vacuum chamber,

- wherein the emission pipe discharges the non-reacted raw
material gas,

wherein the part of the gas flow path has a temperature being gradually reduced, and

wherein the non-reacted raw material gas component in the non-reacted raw material gas is separated out in a space surrounded by another heat insulation in the separator.

41. The equipment according to claim 40,
wherein the separator includes an air-tight sheet disposed on an inner circumference of the space.

42. The equipment according to claim 40,
wherein the separator is capable of vibrating.